Appendix A

Air Resources

BLM Pinedale Field Office
Technical Support Document

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Acronyms

ANC	Acid Neutralizing Capacity
AQRVs	Air Quality Related Values
CAA	Clean Air Act
CASTNet	Clean Air Status and Trends Network
EPA	U.S. Environmental Protection Agency
GCM	Global Change Model
GCRP	U.S. Global Change Research Program
GHGs	Green House Gases
HAPs	Hazardous Air Pollutants
IMPROVE	Interagency Monitoring of Protected Visual Environments
IPCC	International Panel on Climate Change Fifth Assessment Report
NAAQS	National Ambient Air Quality Standards
NADP	National Atmospheric Deposition Program
REA	Rapid Ecoregional Assessment
UGRB	Upper Green River Basin
USGS	U.S. Geological Survey
WAAQS	Wyoming Ambient Air Quality Standards
WAQSR	Wyoming Air Quality Standards and Regulations
WDEQ	Wyoming Department of Environmental Quality-Air Quality Division

1.0 Introduction

Regional air quality is influenced by the interaction of meteorology, climate, the magnitude and spatial distribution of local and regional air pollutant sources (including natural sources), and chemical properties of emitted air pollutants.

Monitoring and enforcement of air quality standards are administered by the Wyoming Department of Environmental Quality-Air Quality Division (WDEQ). Wyoming Ambient Air Quality Standards (WAAQS) and National Ambient Air Quality Standards (NAAQS) identify maximum limits for concentrations of criteria air pollutants at all locations to which the public has access. The WAAQS and NAAQS are legally enforceable standards. Concentrations above the WAAQS and NAAQS represent a risk to human health that, by law, require public safeguards be implemented. State standards must be at least as protective of human health as federal standards, and may be more restrictive than federal standards, as allowed by the Clean Air Act (CAA). Currently, the WDEQ does not have regulations regarding greenhouse gas emissions, although these emissions are regulated indirectly by various other regulations.

Air quality, climate, and visibility are the components of air resources which include applications, activities, and management of the air resource. The BLM must consider and analyze the potential effects of authorized activities on air resources as part of the planning and decision making process. The following sections summarize the existing air quality and climate within the area potentially affected by the proposed action.

2.0 Air Quality

Pollutant concentration can be defined as the mass of pollutant present in a volume of air and is reported in units of micrograms per cubic meter (μg/m3), parts per million (ppm), or parts per billion (ppb). The WDEQ operates an extensive monitoring network within Sublette County.

2.1 Criteria Air Pollutants

The EPA has set NAAQS for the following criteria pollutants: ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter ($PM_{2.5}$ and PM_{10}), and lead (Pb). Air-pollutant concentrations greater than the NAAQS represent a risk to human health. If the air quality in a geographic area meets the NAAQS, it is designated as an *attainment* area; areas that do not meet the NAAQS for any of the criteria pollutants, are designated *nonattainment* areas for that pollutant and must develop comprehensive state plans to reduce concentrations to a safe level.

Criteria air pollutants are those for which national concentration standards have been established. Table A-1 shows both the National and Wyoming Ambient Air Quality Standards (NAAQS/WAAQS).

Table A-1. Criteria Pollutant Ambient Air Quality Standards

Pollutant	Averaging Period	NAAQS[1]	WAAQS[2]	Units	Form of the Standards
O_3	8-hour	0.070	0.075	Parts per million (ppm)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
CO	1-hour	40,000	40,000	$\mu g/m^3$	Not to be exceeded more than once per year
	8-hour	10,000	10,000	$\mu g/m^3$	
NO_2	1-hour	188	189	$\mu g/m^3$	98th percentile, averaged over 3 years
	Annual	100	100	$\mu g/m^3$	Annual mean
PM_{10}	24-hour	150	150	$\mu g/m^3$	Not to be exceeded more than once per year on average over 3 consecutive years
	Annual	NA[3]	50	$\mu g/m^3$	Annual mean
$PM_{2.5}$	24-hour	35	35	$\mu g/m^3$	98th percentile, averaged over 3 consecutive years
	Annual	12	12	$\mu g/m^3$	Annual mean, averaged over 3 consecutive years
SO_2	1-hour	196.5	196.5	$\mu g/m^3$	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years

[1]Source: USEPA National Ambient Air Quality Standards (USEPA 2015b).

[2]Source: WDEQ- Standards and Regulations (WDEQ 2015b).

Ozone. Ozone is formed in the lower atmosphere by a series of reactions involving sunlight and precursor emissions of nitrous oxides (NOx) and volatile organic compounds (VOCs). Ozone and its precursors can be transported both into and out of the region.

Compliance with the 8-hour ozone NAAQS is based on the ozone "design value," which is defined as the 3-year average of the annual fourth-highest observed 8-hour average ozone concentration. An ozone design value is first calculated for each monitoring site within a given area. The area-wide ozone design value is then defined as the maximum over all sites within the area. If the design value exceeds the 8-hour ozone NAAQS of 70 parts per billion (ppb), the area is designated nonattainment (September 2015). [Note: The Marginal designation for the UGRB was based on the previous standard of 75 ppb to be discussed herein.]

Ozone is currently measured at 5 monitoring sites within Sublette County. All of the sites have sufficient data to calculate one or more 3-year design values. Ozone design values for each of these sites, for three recent 3-year design value periods (2010–2012, 2011–2013, and 2012–2014), are listed in Table A-2.

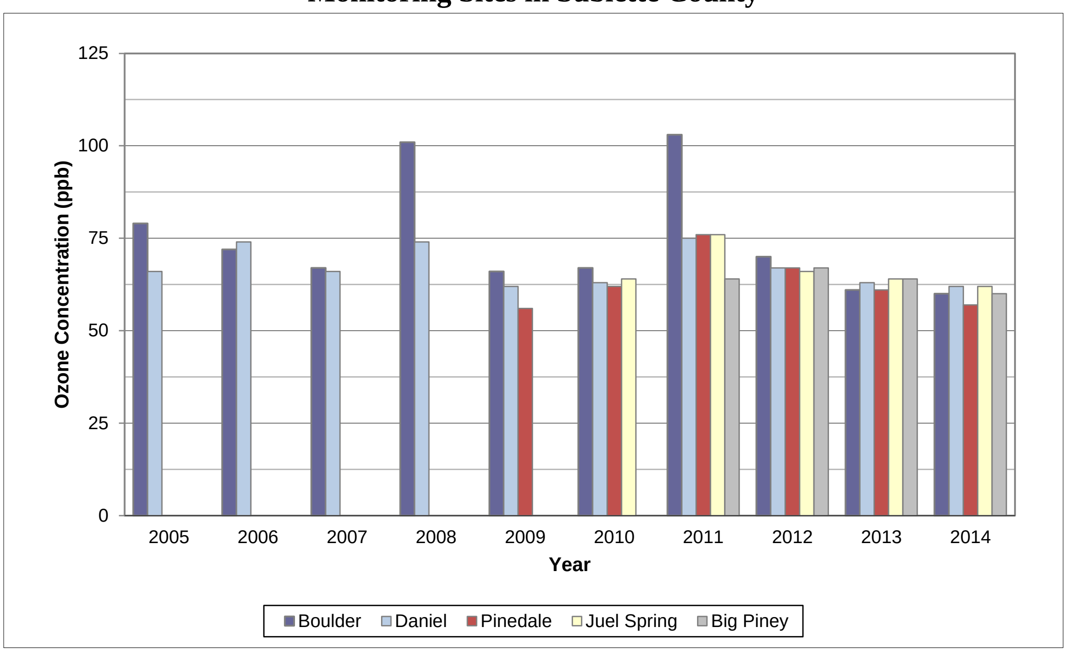
Table A-2. Ozone Design Values for 2010–2012 through 2012–2014 for Ozone Monitoring Sites in Sublette County Compared with the NAAQS

Site Name	ID	County	Ozone Design Value (ppb)			NAAQS (ppb)
			2010–2012	2011–2013	2012–2014	
Big Piney	56-035-0700	Sublette	--	65	63	70
Boulder	56-035-0099	Sublette	80	78	63	70
Daniel South	56-035-0100	Sublette	68	68	64	70
Juel Spring	56-035-0700	Sublette	68	68	64	70
Pinedale	56-035-0101	Sublette	68	68	61	70

Source: REF 1018
NAAQS National Ambient Air Quality Standards
ppb parts per billion

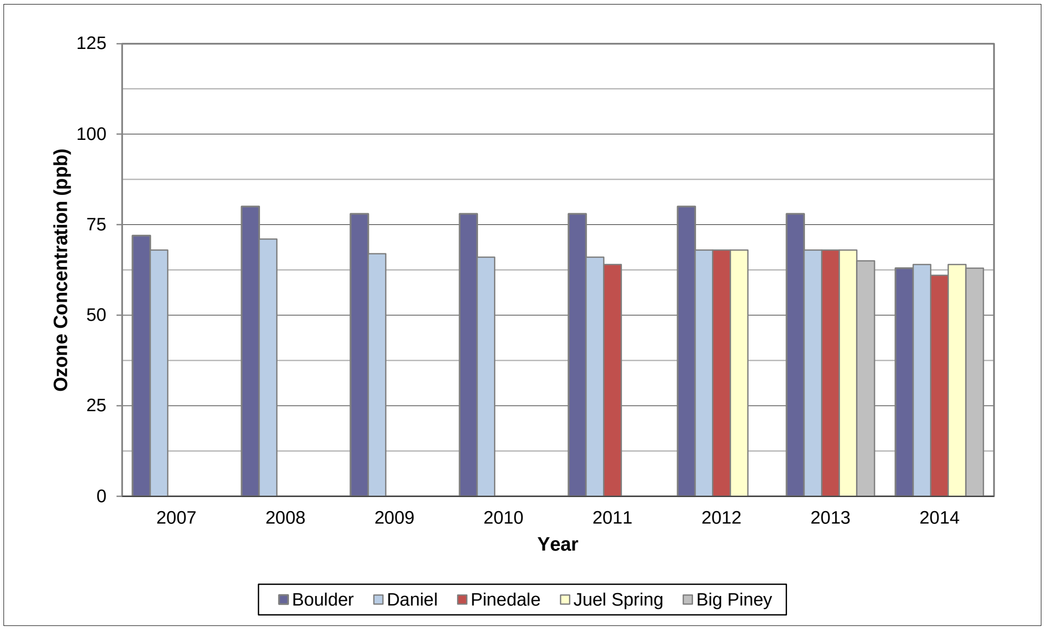
The design values for the Boulder monitoring site for the 2010-2012 and 2011-2013 design value periods are greater than the 2015 NAAQS. For the 2012-2014 period, the values are much lower and are below the NAAQS for all sites. Figure A-1 displays the fourth-highest 8-hour average ozone concentrations and Figure A-2 displays the 8-hour ozone design values for the monitoring sites for all years with available data. As noted earlier, the fourth-highest 8-hour average ozone concentration for each year is used to calculate the design value and assess compliance with the ozone NAAQS.

Figure A-1. Fourth Highest 8-Hour Average Ozone Concentration (parts per billion) for Monitoring Sites in Sublette County



Data Source: REF 1018
Note: The NAAQS for 8-hour average ozone concentration is 70 ppb.
NAAQS National Ambient Air Quality Standards
ppb parts per billion

Figure A-2. 8-Hour Ozone Design Values (parts per billion) for Monitoring Sites in Sublette County



On April 30, 2012, the EPA formally designated the UGRB as a 'Marginal' ozone nonattainment area, effective July 20, 2012 based on an ozone 8-hour standard of 75 ppb. As a result of the nonattainment designation, the BLM must comply with General Conformity regulations in 40 CFR 93 subpart B and Chapter 8, Section 3 of the Wyoming Air Quality Standards and Regulations (WAQSR) for any federal action within the designated nonattainment area.

The BLM is required to conduct a General Conformity analysis and cannot approve any action that would cause or contribute to a new violation of the NAAQS or increase the frequency or severity of any existing violation. A formal General Conformity determination must be conducted for any action where the total of direct and indirect emissions for the proposed action exceeds the de minimis levels specified in 40 CFR 93.153(b) and WAQSR Chapter 8, Section 3. For projects located in a marginal ozone nonattainment area, this de minimis level is 100 tons per year (tpy) of VOC or NOx. For projects that are below the de minimis threshold level of 100 tpy for NOx or VOC, the BLM must complete a conformity analysis and demonstrate that the proposed project will not exceed the de minimis threshold level and is therefore exempt from requiring a conformity determination.

<u>Nitrogen Dioxide</u>. NO_2 is currently measured at five monitoring within Sublette County. Relevant NAAQS for NO_2 include (1) the 1-hour NO_2 NAAQS, which requires the 3-year average of the 98th percentile daily maximum 1-hour NO_2 concentration to be less than 100 ppb; and (2) the annual NO_2 NAAQS, which requires the annual average NO_2 concentration to be less than 53 ppb. All nine sites have sufficient data to calculate one or more 3-year average 1-hour NO_2 values. One-hour NO_2 design values for each of these sites, for 2010–2012, 2011–2013, and 2012–2014, are listed in Table A-3.

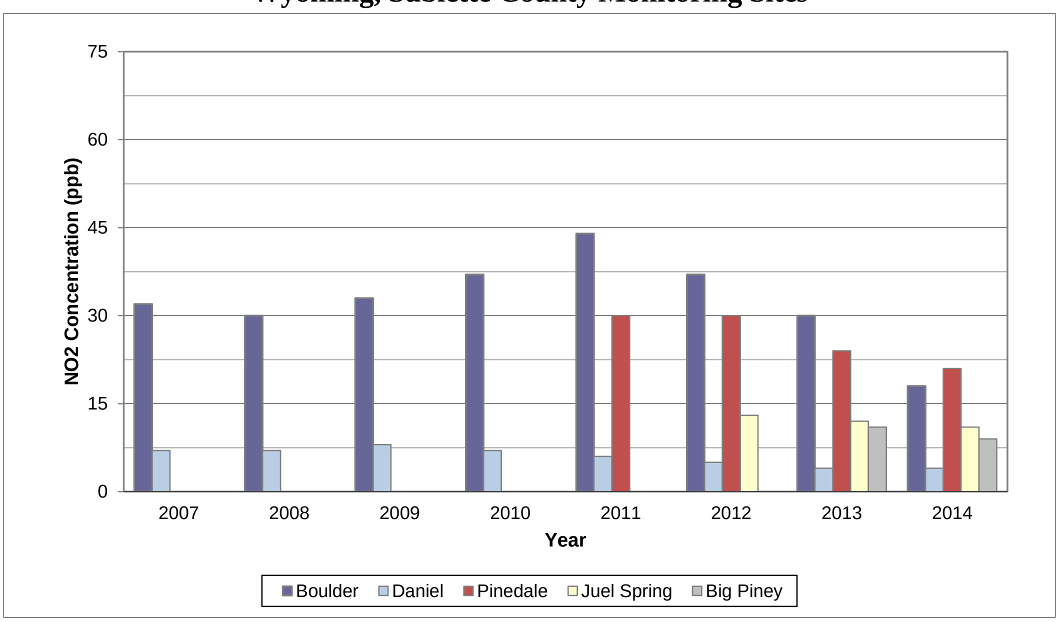
Table A-3. Design Values for 2010–2012 through 2012–2014 for NO2 Monitoring Sites in Sublette County Compared with the NAAQS

Site Name	ID	County	3-Year Average 98th Percentile 1-Hour NO2 (ppb)			NAAQS (ppb)
			2010–2012	2011–2013	2012–2014	
Big Piney	56-035-0700	Sublette	--	10	9	100
Boulder	56-035-0099	Sublette	37	30	18	100
Daniel South	56-035-0100	Sublette	5	4	4	100
Juel Spring	56-035-0700	Sublette	13	12	11	100
Pinedale	56-035-0101	Sublette	30	24	21	100

Source: REF 1018
NAAQS National Ambient Air Quality Standards
NO2 nitrogen dioxide
ppb parts per billion

The highest design values occur at the Boulder and Pinedale monitoring sites. The design values are consistent across the three multi-year periods, and none of the design values exceed the 1-hour NO_2 NAAQS. The data also indicate compliance with the annual NO_2 NAAQS. Figure A-3 displays the 1-hour NO_2 design values for the ozone monitoring sites for all years with available data. As noted earlier, the 98th percentile (or eighth-highest) daily maximum 1-hour NO_2 concentration for each year is used to calculate the design value for each site and assess compliance with the NAAQS.

Figure A-3. 1-Hour NO_2 Design Values (parts per billion) for Monitoring Sites in Southwestern Wyoming, Sublette County Monitoring Sites



Sulfur Dioxide. The closest SO_2 monitoring site is located at the Moxa monitoring site (in Sweetwater County). This site was established in 2010. The 99th percentile daily maximum 1-hour SO_2 values are 21, 17, 16, 20 and 16 ppb for 2010 through 2014. The corresponding SO_2 design values are 18, 17 and 17 ppb for 2010–2012, 2011–2013 and 2012-2014, respectively, as listed in Table 4-A. The 1-hour SO_2

NAAQS sets a limit of 75 ppb for the 3-year average of the 99th percentile daily maximum 1-hour value. Therefore, the SO_2 design values are well below the NAAQS and SO_2 is not a pollutant of concern for the region. Note, however, that SO_2 monitoring is limited to one site.

Table A-4. Three-Year Average 99th Percentile Daily Maximum 1-Hour SO2 Values for 2010–2012 through 2012-2014 for Monitoring Sites in Southwestern Wyoming Compared with the NAAQS

Site Name	ID	County	3-Year Average 99th Percentile 1-Hour SO2 (ppb)			NAAQS (ppb)
			2010–2012	2011–2013	2012–2014	
Moxa	56-037-0300	Sweetwater	18	17	17	75

Source: REF 1018
NAAQS National Ambient Air Quality Standards
ppb parts per billion
SO2 sulfur dioxide

Carbon Monoxide. CO is not routinely monitored within the region. CO was measured at the Murphy Ridge site (in Uinta County) during 2008. Based on these measurements, the daily maximum 1-hour CO value was 870 ppb (0.87 parts per million [ppm]) and the daily maximum 8-hour average CO value was 690 ppb (0.69 ppm). These values are well below the NAAQS limits of 35,000 and 9,000 ppb (35 and 9 ppm), respectively. Therefore, CO does not appear to be a pollutant of concern for the region. Note, however, that CO monitoring is limited to one site.

The 2011 National Emission Inventory indicates that CO emissions in the region are primarily from area (mostly oil and gas–related) and on-road mobile sources. CO concentrations are expected to be greatest near human-made CO sources such as oil and gas development areas, population centers, and roadways, but CO is not a primary air quality concern for the region.

Lead. Lead is not routinely monitored and is not a primary air quality concern for the region.

Particulate Matter. PM_{10} and $PM_{2.5}$ are pollutants of concern within the region. At the regional scale, it is expected that fugitive dust sources are the dominant contributors to PM_{10} and $PM_{2.5}$ concentrations. Fugitive dust is likely to occur naturally across the region, especially during high-wind events. Post-burn vegetative conditions associated with wildfires are also sources of fugitive dust. At the local level, concentrations are expected to be highest near towns, unpaved roads that experience high volumes of traffic, areas with depleted vegetative cover, and areas downwind of human-made sources of precursor emissions such as SO_2 and NO_2 that may react to form secondary $PM_{2.5}$.

Recent PM_{10} data are available for three monitoring sites within the region. Under the PM_{10} NAAQS, the maximum 24-hour average PM_{10} concentration cannot exceed 150 micrograms per cubic meter (µg/m3) more than once per year on average over 3 years. WDEQ also requires the annual PM_{10} concentration to be less than 50 µg/m3. Maximum 24-hour PM10 concentrations for monitoring sites within the area are listed in Table A-5.

Table A-5. Maximum 24-Hour PM10 Concentrations for Monitoring Sites in Sublette County Compared with the NAAQS

Site Name	ID	County	Maximum 24-Hour Average PM10 (µg/m3)			NAAQS (µg/m3)
			2012	2013	2014	
Big Piney	56-035-0700	Sublette	190	59	--	150
Boulder	56-035-0099	Sublette	68	41	31	150
Daniel	56-035-0100	Sublette	72	41	26	150

Source: REF 1018

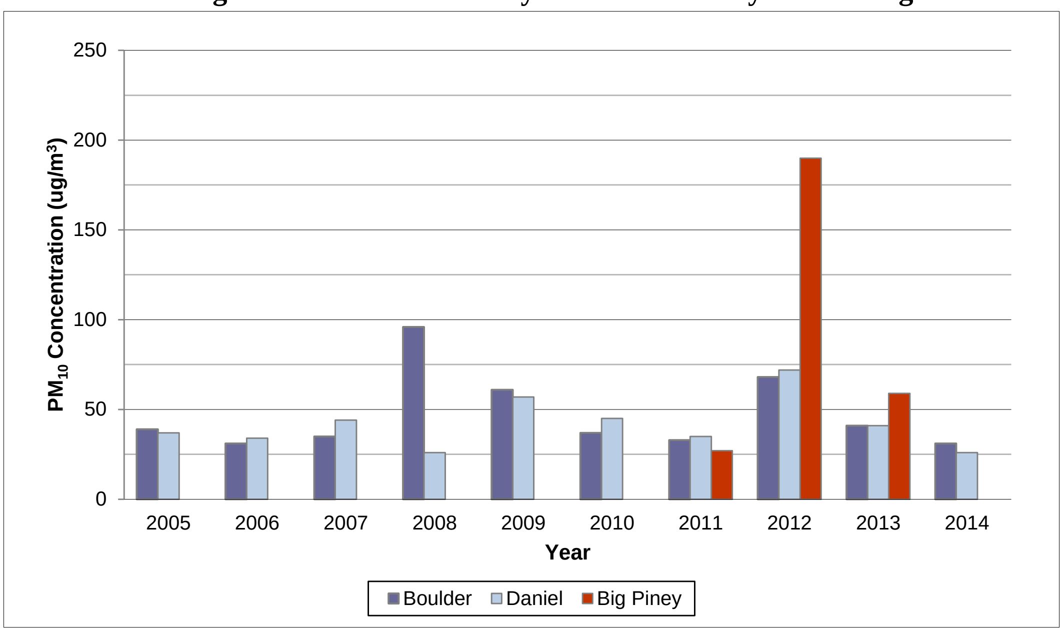
NAAQS National Ambient Air Quality Standards

PM10 particulate matter less than 10 microns in diameter

µg/m3 micrograms per cubic meter

PM_{10} concentrations exceeded 150 µg/m3 for 1 of the 3 periods at the Big Piney site. Therefore, while there are no violations of the PM_{10} NAAQS, PM_{10} is an air quality concern for the region. Figure A-4 displays the maximum 24-hour PM10 concentration for these sites for all years with available data.

Figure A-4. Maximum 24-Hour PM_{10} Design Values (micrograms per cubic meter) for Monitoring Sites in Sublette County - Sublette County Monitoring Sites



Recent $PM_{2.5}$ data are available for two monitoring sites within the region. The NAAQS for $PM_{2.5}$ include (1) the 24-hour $PM_{2.5}$ NAAQS, which requires the 3-year average of the 98th percentile 24-hour average $PM_{2.5}$ concentration to be less than 35 µg/m3; and (2) the annual $PM_{2.5}$ NAAQS, which requires the 3-year average of the annual average $PM_{2.5}$ concentration to be less than 12 µg/m3. The 24-hour $PM_{2.5}$ design values are listed in Table A-6 and the annual $PM_{2.5}$ design values are listed in Table A-7. The 24-hour $PM_{2.5}$ design values are below the NAAQS for both sites.

Table A-6. 24-Hour PM2.5 Design Values for 2010–2012 through 2012–2014 for Monitoring Sites in Sublette County Compared with the NAAQS

Site Name	ID	County	3-Year Average 98th Percentile 24-Hour PM2.5 (µg/m3)			NAAQS (µg/m3)
			2010–2012	2011–2013	2012–2014	
Big Piney	56-035-0700	Sublette	--	23.3	--	35
Pinedale	56-035-0101	Sublette	16.0	17.0	17.3	35

Source: REF 1018

NAAQS National Ambient Air Quality Standards

PM2.5 particulate matter less than 2.5 microns in diameter

µg/m3 micrograms per cubic meter

Table A-7. Annual PM2.5 Design Values for 2010–2012 through 2012–2014 for Monitoring Sites in Sublette County Compared with the NAAQS

Site Name	ID	County	3-Year Average 98th Percentile 24-Hour PM2.5 (µg/m3)			NAAQS (µg/m3)
			2010–2012	2011–2013	2012–2014	
Big Piney	56-035-0700	Sublette	--	4.3	--	12
Pinedale	56-035-0101	Sublette	5.1	5.6	5.8	12

Source: REF 1018

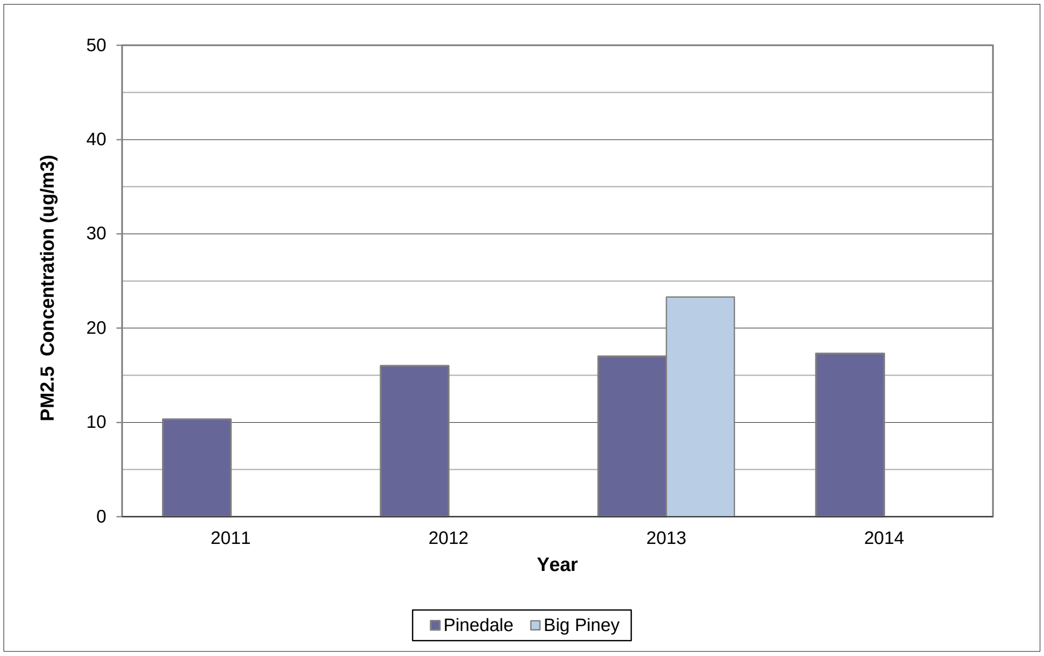
NAAQS National Ambient Air Quality Standards

PM2.5 particulate matter less than 2.5 microns in diameter

µg/m3 micrograms per cubic meter

The annual $PM_{2.5}$ design values are also below the NAAQS for both sites. Figure A-5 displays the 24-hour $PM_{2.5}$ design value and Figure A-6 displays the annual average concentration for each 3-year period with available data. The design values are based on 3 years of data. For both the 24-hour and annual metrics, the data indicate a slight upward trend in $PM_{2.5}$ for the Pinedale site.

Figure A-5. 24-Hour PM2.5 Design Values (micrograms per cubic meter) for Monitoring Sites in Sublette County



Source: REF 1018

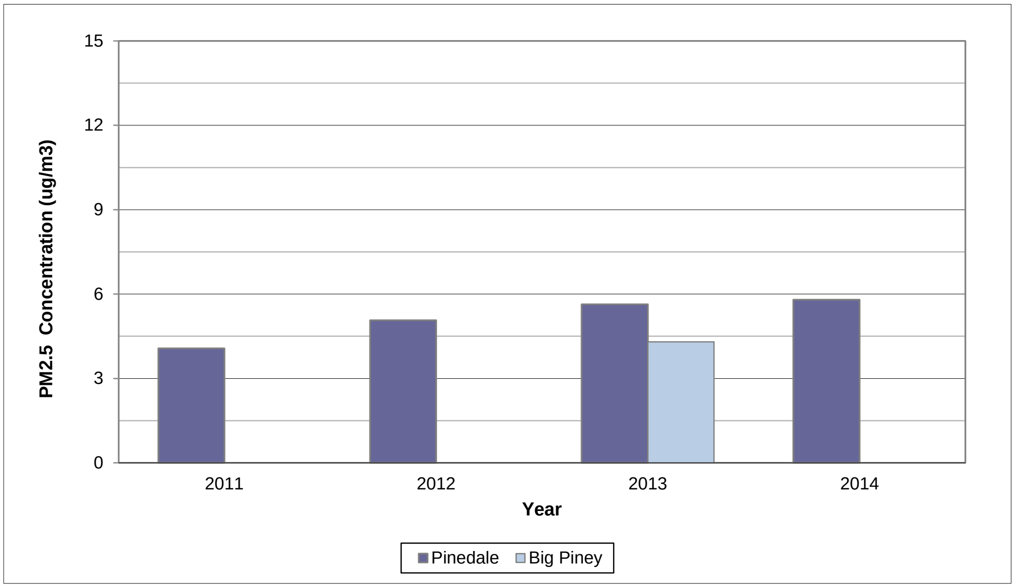
Note: The NAAQS for 24-hour PM2.5 is 35 μg/m3.

μg/m3 micrograms per cubic meter

NAAQS National Ambient Air Quality Standards

$PM_{2.5}$ particulate matter 2.5 microns or less in diameter

Figure A-6. Annual Average PM2.5 Design Values (micrograms per cubic meter) for Monitoring Sites in Sublette County



Source: REF 1018

Note: The NAAQS for annual average PM2.5 is 12 μg/m3.

μg/m3 micrograms per cubic meter

NAAQS National Ambient Air Quality Standards

$PM_{2.5}$ particulate matter 2.5 microns or less in diameter

2.2 Air Quality Related Values

<u>Visibility</u>. The regional haze rule promulgated by EPA in 1999 requires states to establish Reasonable Progress Goals for improving visibility with the overall goal of attaining natural visibility conditions for Class I areas by 2064.
Table Table A-8 compares visibility in deciviews for the two Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring sites in Sublette County for 2014 with the natural visibility conditions established by EPA for the Bridger Wilderness Area. The 2014 data indicate that natural background goals are achieved for the 20 percent best days for both sites. However, the deciview values for the 20 percent worst days and for all days are greater than natural background.

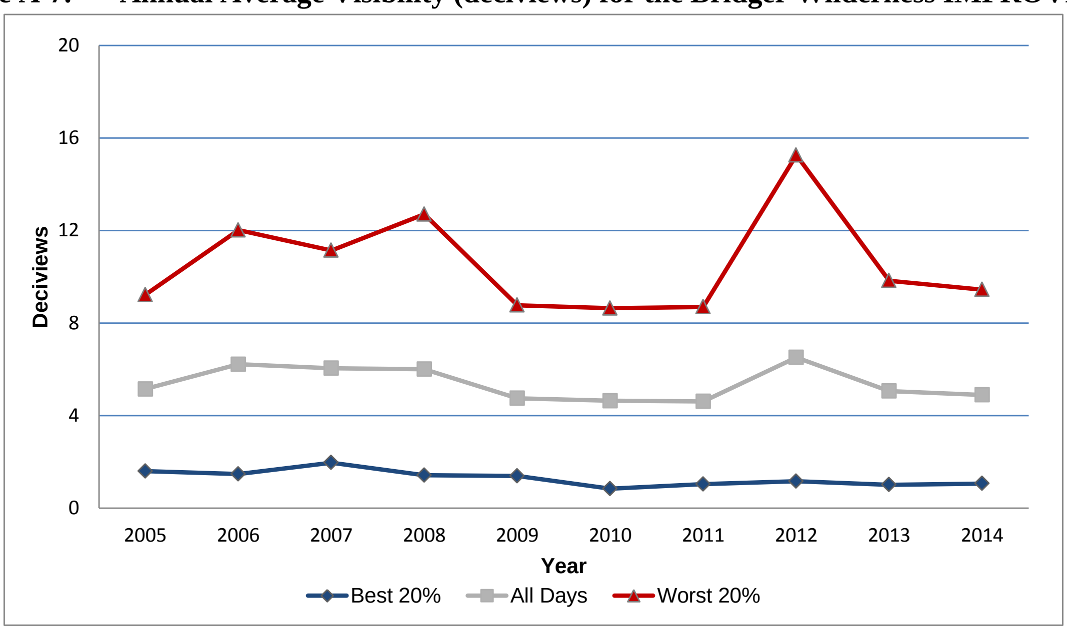
Table A-8. Summary of Visibility Conditions (deciviews) for 2014 for IMPROVE Sites in Southwestern Wyoming Compared with Natural Visibility Conditions

Site	20% Best Days (dv)		20% Worst Days (dv)		All Days (dv)	
	IMPROVE	Natural	IMPROVE	Natural	IMPROVE	Natural
Bridger Wilderness (BRID1)	1.1	2.0	9.4	7.1	4.9	4.5
Boulder Lake (BOLA1)	1.4	2.0	9.1	7.1	4.9	4.5

Sources: REF 1014; REF 1019
% percent
dv deciviews

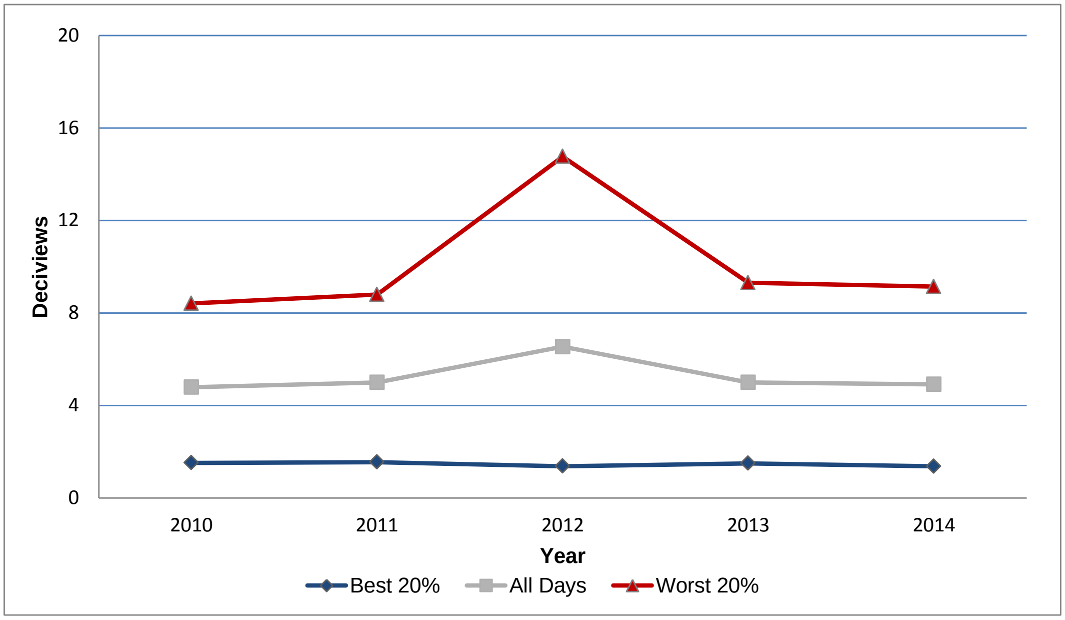
Figures A-7 and A-8 display annual average visibility in deciviews for the 20 percent best days, 20 percent worst days, and all days for each year during the period from 2005 to 2014 for the Bridger Wilderness Area IMPROVE site and for 2010 to 2014 for the Boulder Lake IMPROVE site.

Figure A-7. Annual Average Visibility (deciviews) for the Bridger Wilderness IMPROVE Site



Source: REF 1014
% percent

Figure A-8. Annual Average Visibility (deciviews) for the Boulder Lake IMPROVE Site



Source: REF 1014
% percent

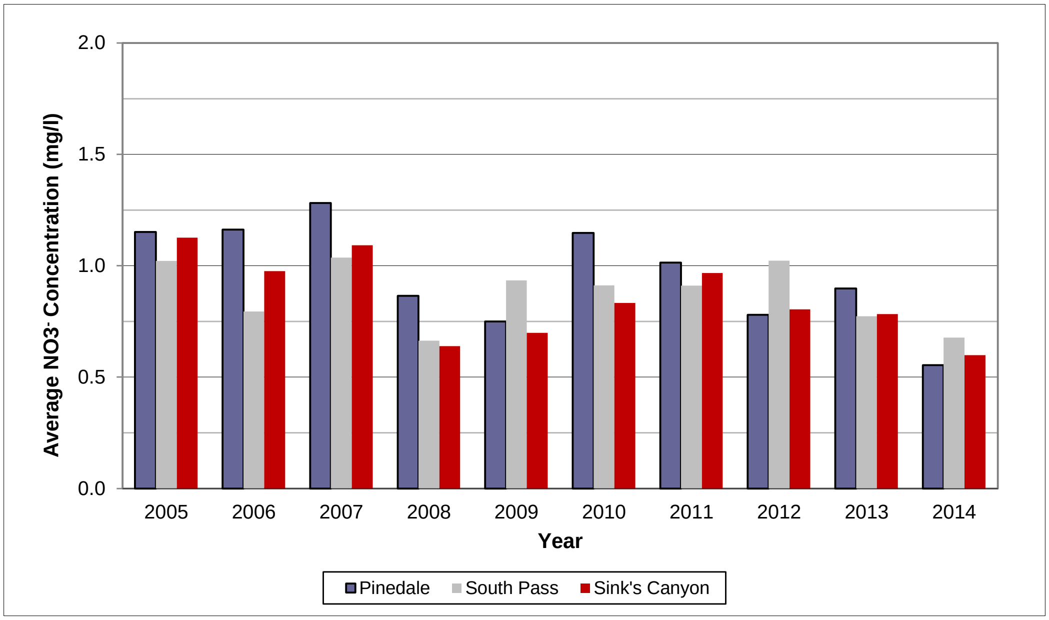
The data for Bridger Wilderness indicate a slight downward trend (improved visibility) for the 20 percent best days during the 2002–2014 period. Only the trend for the 20 percent best days is statistically significant. For the other two categories of days, the data are quite variable and it is difficult to distinguish a trend. Visibility for 2012 is especially poor, compared with that of most other years, likely because of wildfires that occurred in several surrounding states in 2012.

Data collection for Boulder Lake began in mid-2009. The data for 2010 through 2014 show no apparent trend in visibility for any of the categories of days. There is an increase in deciviews (poorer visibility) for 2012, compared with that for the other years.

Deposition and Lake Chemistry. Atmospheric deposition of air pollutants can increase the acidity of soils and water resources. Atmospheric deposition is measured at one National Atmospheric Deposition Program (NADP) site (wet deposition) and one Clean Air Status and Trends Network (CASTNet) site (dry deposition) in Pinedale (Sublette County) and two NADP sites in Fremont County. Wet deposition is characterized by the concentration of nitrate ion (NO_3-), sulfate ion (SO_4-), and ammonium ion in precipitation samples.

Figures A-9 through A-11 display annual average concentration data for nitrate, sulfate, and ammonium ions from precipitation samples for each year during the period from 2005 to 2014 for the NADP sites. For each year, the data represent the average concentration based on all sampling periods. Units are milligrams per liter (mg/L).

Figure A-9. Annual Average Concentration in Wet Deposition (milligrams per liter) for NADP Monitoring Sites at Pinedale, South Pass, and Sink's Canyon: Nitrate Ion Concentration

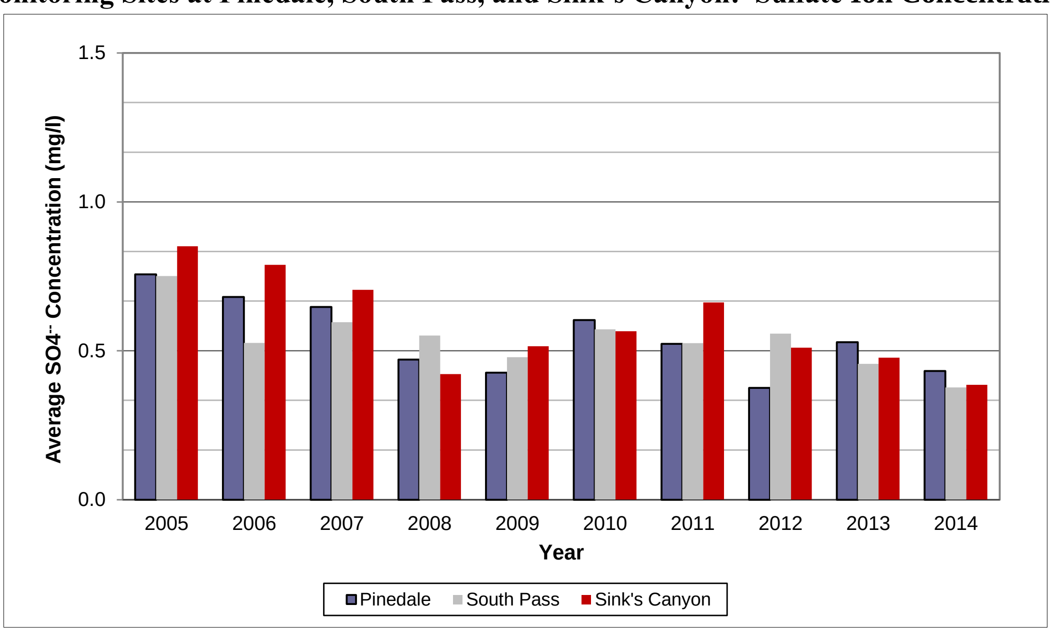


Source: REF 1014

mg/L milligrams per liter

NO_3- nitrate ion

Figure A-10. Annual Average Concentration in Wet Deposition (milligrams per liter) for NADP Monitoring Sites at Pinedale, South Pass, and Sink's Canyon: Sulfate Ion Concentration

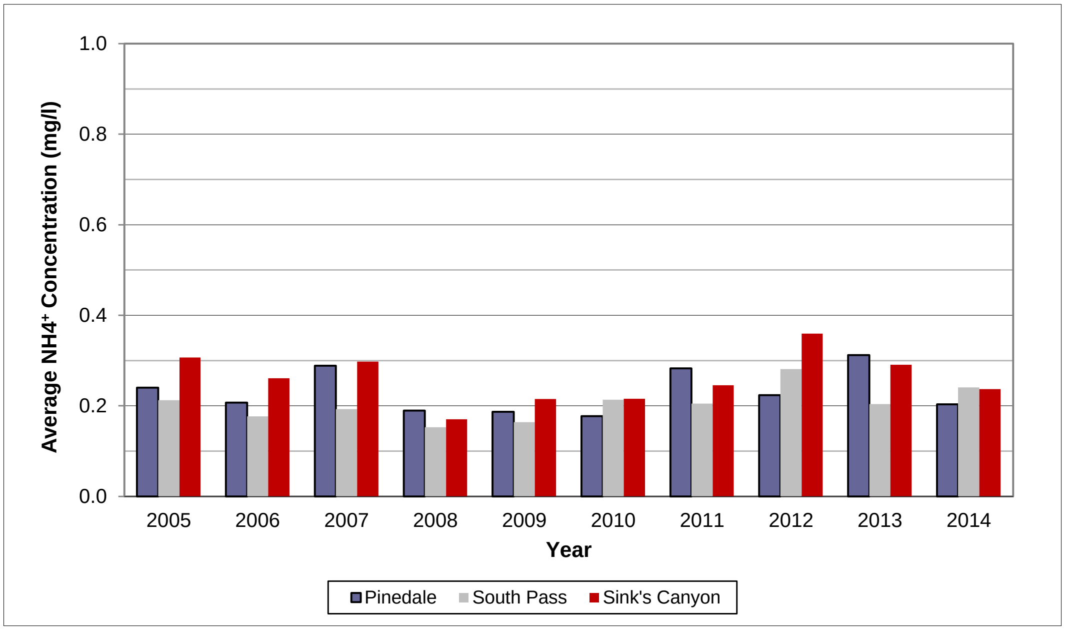


Source: REF 1014

mg/L milligrams per liter

SO_4 - sulfate ion

Figure A-11. Annual Average Concentration in Wet Deposition (milligrams per liter) for NADP Monitoring Sites at Pinedale, South Pass, and Sink's Canyon: Ammonium Ion Concentration

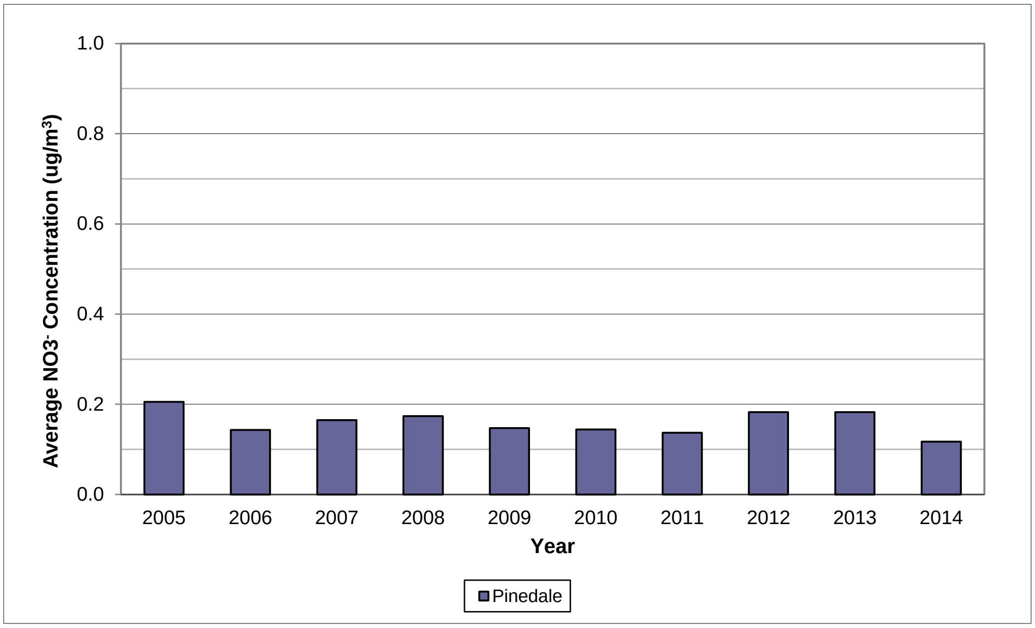


Source: REF 1014
mg/L milligrams per liter
NH_4+ ammonium ion

The data indicate a decrease over time for nitrate and sulfate ions for all three sites in precipitation samples during this period. There is no discernible trend in ammonium ions. For Pinedale and Sink's Canyon, the downward trends are statistically significant for nitrate and sulfate. For South Pass, the downward trend is statistically significant for sulfate.

Figures A-12 through A-14 display annual average concentration data for nitrate, sulfate, and ammonium ions for each year during the period from 2005 to 2014 for the Pinedale CASTNet site. The concentration measurements are used to estimate dry deposition. For each year, the data represent the average concentration based on all sampling periods. Units are µg/m3.

Figure A-12. Annual Average Concentration (micrograms per cubic meter) for the CASTNet Monitoring Site at Pinedale: Nitrate Ion Concentration

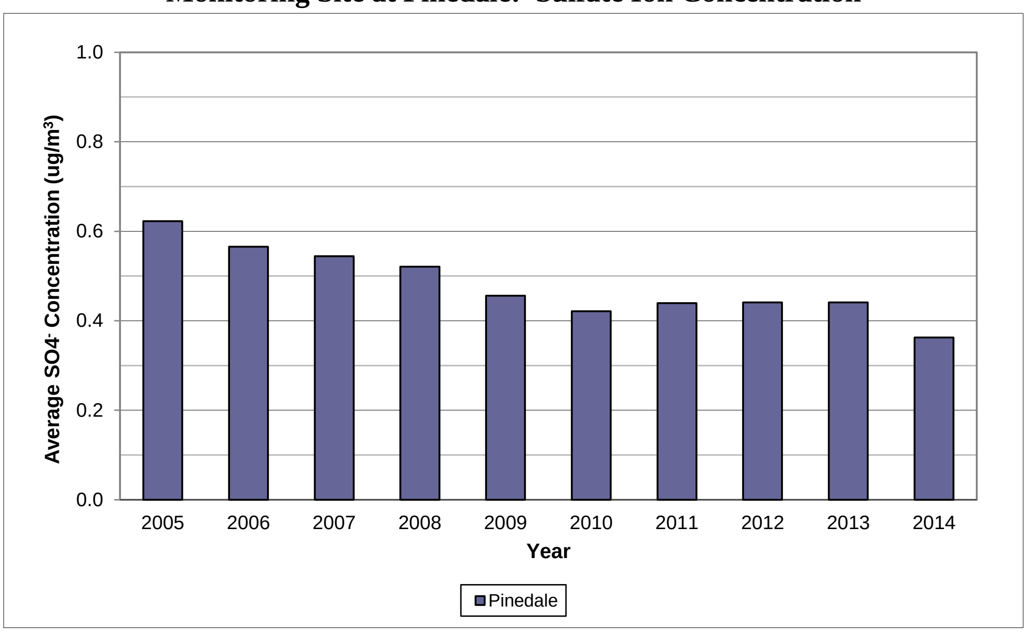


Source: REF 1014

µg/m3 micrograms per cubic meter

NO_3- nitrate ion

Figure A-13. Annual Average Concentration (micrograms per cubic meter) for the CASTNet Monitoring Site at Pinedale: Sulfate Ion Concentration

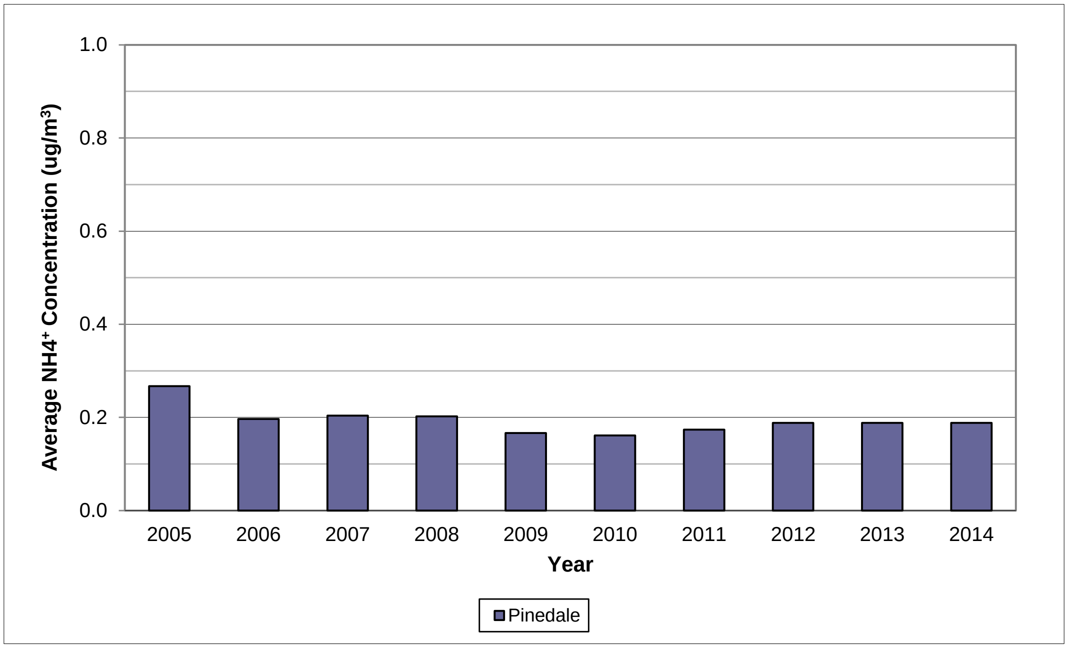


Source: REF 1014

µg/m3 micrograms per cubic meter

SO_4 - sulfate ion

Figure A-14. Annual Average Concentration (micrograms per cubic meter) for the CASTNet Monitoring Site at Pinedale: Ammonium Ion Concentration



Source: REF 1014
µg/m3 micrograms per cubic meter
NH_4+ ammonium ion

The concentration data that are used to estimate dry deposition indicate a decrease over time for all three pollutant species in air samples taken during this period. The downward trend is slight for NO_3- and ammonium ions and is more pronounced (and statistically significant) for the SO_4- concentrations. Seven lakes have been identified as being acid sensitive. Applicable thresholds for the assessment of changes in Acid Neutralizing Capacity (ANC) of sensitive lakes include: 10 percent change in ANC for lakes with background ANC values greater than 25 micro equivalents per liter [µeq/L], and less than a 1 µeq/L change in ANC for lakes with background ANC values equal to or less than 25 µeq/L.

Available ANC values for each of the nearest sensitive lakes are provided in Table A-9, along with the number of samples used in the calculation of the 10th percentile lowest ANC values. Of the seven lakes listed in Table A-9, only Upper Frozen Lake is considered to be extremely sensitive to atmospheric deposition by the USFS since the background ANC is less than 25 µeq/L.

Table A-9. Background ANC Values for Acid Sensitive Lakes

Wilderness Area	Lake	Latitude (Deg, Min, Sec)	Longitude (Deg, Min, Sec)	10th Percentile Lowest ANC Value (µeq/l)	Number of Samples
Bridger	Deep	42°43’10”	109°10’15”	61.1	62
Bridger	Black Joe	42°44’22”	109°10’16”	70.6	72
Bridger	Lazy Boy	43°19’57”	109°43’47”	27.8	1
Bridger	Upper Frozen	42°41’13”	109°09’39”	13.2	3
Bridger	Hobbs	43°02’08”	109°40’20”	69.8	76
Fitzpatrick	Ross	43°22’41”	109°39’30”	54.0	55
Popo Agie	Lower Saddlebag	42°37’24	108°59’38”	55.5	54

Source: USFS (2011)
Deg Degree
Min Minute
Sec Second
µeq/l Microequivalent per liter

2.3 Hazardous Air Pollutants

Many VOCs are HAPs and are associated with human-made sources. The 2011 National Emission Inventory and 2008 and later WDEQ emissions inventories indicate that VOC emissions within the region are primarily from area sources associated with oil and gas development activities. Therefore, HAP concentrations are expected to be greatest near oil and gas development sources and are a potential air quality concern for the region.

HAPs are not routinely monitored within the region. However, WDEQ conducted HAP monitoring for several sites from February 2009 until March 2010.

Table A-10 summarizes observed HAP concentrations for the Boulder, Daniel South, and Pinedale monitoring sites. Measurements were taken every six days and the values represent averages for the entire monitoring period.

Table A-10. Example HAP Concentrations (micrograms per cubic meter) for Sublette County, Wyoming

Site Name	Annual Average HAP Concentration (µg/m3)					
	Benzene	Ethyl-benzene	Formalde-hyde	Hexane	Toluene	Xylene
Boulder	2.12	0.77	0.99	1.29	6.42	4.46
Daniel South	1.25	0.52	1.37	0.81	4.30	2.76
Pinedale	2.13	1.00	1.59	1.47	6.50	6.38

Source: REF 1020
µg/m3 micrograms per cubic meter

3.0 Climate Change (Greenhouse Gases)

Throughout southwestern Wyoming, a number of resources could be affected by alterations in future weather and land-use conditions resulting from possible changes in the overall climate of the region. Meteorological data collected throughout the world during the last 50 years show strong indications of a warming planet. Other environmental data collected from oceans, wetlands, forests, and the polar regions (associated with ice pack extent, thickness, and melting) corroborate the global warming trend. It is well known that certain gases in the atmosphere allow short-wave radiation from sunlight (visible light, ultraviolet, near infrared) through the atmosphere. These gases include CO_2, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulfur hexafluoride (SF_6), VOCs, water vapor, and other trace gases. When the sun's radiation strikes Earth's surface, heat is generated in the form of infrared radiation. These same gases act to absorb longer wave infrared radiation, resulting in a warming of the atmosphere. This phenomenon is known as the "greenhouse effect," because these gases, referred to as greenhouse gases (GHGs), act to trap heat in the atmosphere in a similar manner as a greenhouse.

Throughout Earth's history, the proportions of the major constituents of the atmosphere (oxygen and nitrogen, which make up 99 percent of the atmosphere) have changed somewhat due to natural and geogenic processes. The concentrations of minor constituents such as CO_2, CH_4, N_2O, and water vapor have also varied somewhat throughout history. Since the advent of the Industrial Revolution in the 1700s, fossil fuels (coal, oil, and natural gas) have been used for heat and power generation throughout the world. This has resulted in increases in the concentrations of GHGs, compared to pre-industrial concentrations, as estimated using long-term historical records of ice-core samples. During the last 50 years, the rate of this increase in GHG concentrations, especially CO_2, has shown a dramatic upward trend, likely due to the increased burning of fossil fuels brought on by larger populations demanding more energy throughout the world, especially in Asia and other newly developing countries. The increases in CO_2 are due to the use of fossil fuels and certain changes in land use. The major human activities that cause increases in CH_4 are coal mining and releases of natural gas from oil and gas operations and the major human activities that cause increases in both CH_4 and N_2O include animal manure management, agricultural soil management, sewage treatment, and combustion of fossil fuels in stationary and mobile sources (IPCC, 2014).

3.1 Indicators

In the region, most GHG emissions, primarily in the form of CO_2, result from the combustion of fossil fuels for oil and gas drilling and production operations and transportation. Energy demand, which is the main driver for natural gas development, is influenced by regional and national population growth, economic development, and seasonal weather conditions. CH4 emissions also result from the development of fossil fuel resources, landfills, and agricultural and livestock activities.

3.2 Current Conditions

Throughout the Mountain West, including southwestern Wyoming, numerous types of activities and actions result in GHG emissions, with the largest contributor being the combustion of fossil fuels in power plants; on-road and off-road vehicles; drilling engines, pumps, and compressors used in oil and natural development; and construction equipment. In addition to direct GHG emissions from these activities, indirect GHG emissions and other factors potentially contributing to climate change include electricity generated outside the analysis area, land-use changes (e.g., converting forested areas to agricultural use), and soil erosion.

3.3 Trends

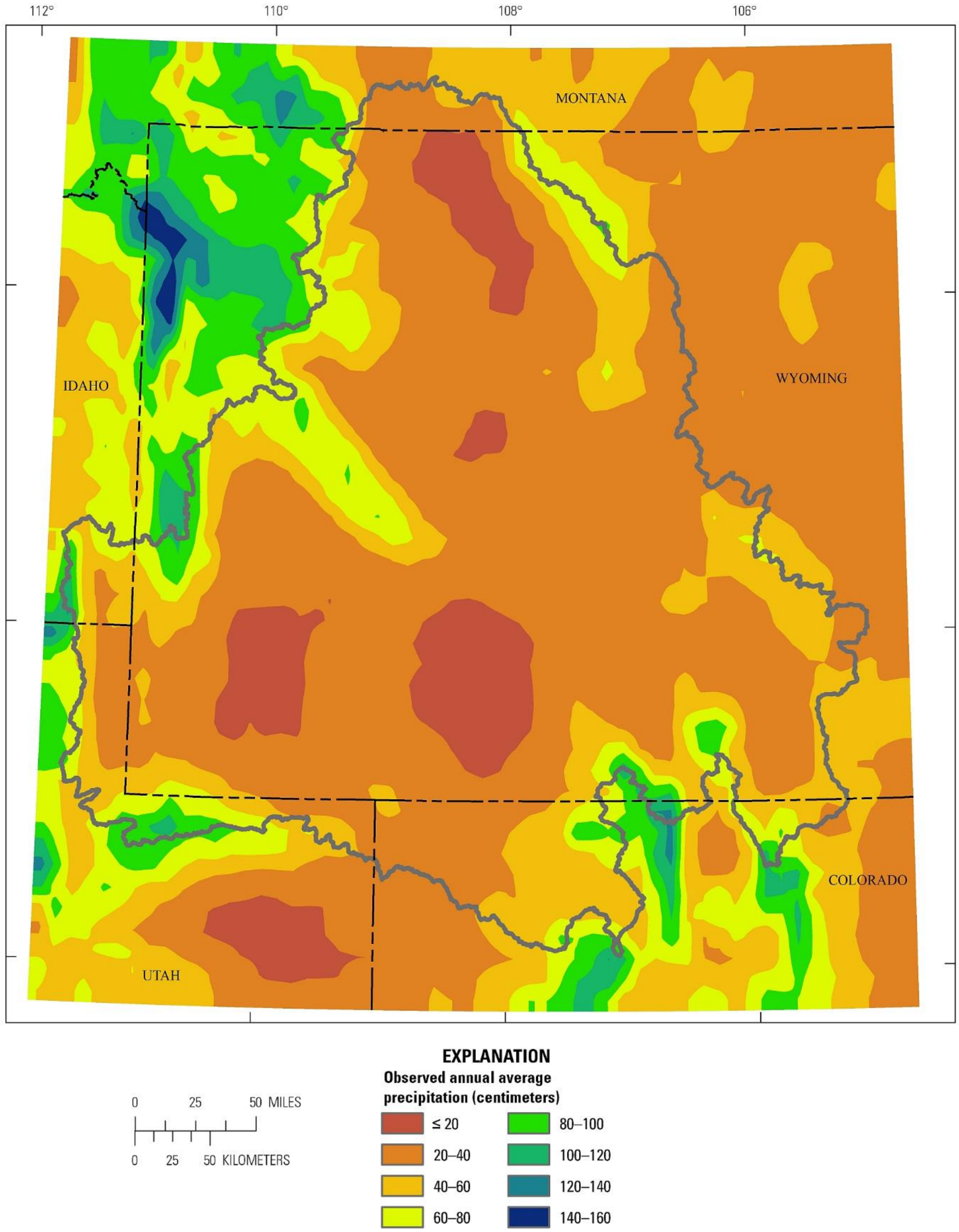
According to climate change researchers, the effects of climate change are expected to vary by region, season, and time of day. Computer model forecasts indicate that increases in temperature will not be evenly or equally distributed, but are likely to be accentuated at higher latitudes. Warming during winter is expected to be greater than during the summer, and increases in daily minimum temperatures are more likely than increases in daily maximum temperatures. Within a given region, increasing temperatures also could affect the amount of water vapor in the atmosphere, the timing and amount of precipitation, the intensity of storm systems, snow melt, and soil moisture. All of these factors can affect climate, day-to-day weather conditions, plant physiology, and air quality.

Based on research compiled for the International Panel on Climate Change Fifth Assessment Report, (IPCC, 2014) potential effects of climate change on resources in the affected environment are likely to be varied. Within North America, the report specifically forecasts that: warming in western mountains is projected to cause decreased snowpack, more winter flooding and reduced summer flows, exacerbating competition for over-allocated water resources; in the early decades of the century, moderate climate change is projected to increase aggregate yields of rain-fed agriculture by 5 to 20 percent, but with important variability among regions; major challenges are projected for crops that are near the warm end of their suitable range or which depend on highly utilized water resources; cities that currently experience heat waves are expected to be further challenged by an increased number, intensity and duration of heat waves during the course of the century, with potential for adverse health impacts; and coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution.

Specific modeling and/or assessments of the potential effects for the State of Wyoming currently do not exist; however, there are downscaled models that have been applied for the area such as a Rapid Ecoregional Assessment (REA) and the 2014 National Climate Assessment (GCRP, 2014).
Recently, the USGS completed the Wyoming Basin Rapid Ecoregional Assessment (USGS, 2015) and presented the results of the climate change analysis for this ecoregion. The analysis provided estimates of expected changes in environmental factors (e.g., precipitation, temperature, etc.) based on information derived from multiple global change models (GCM). The analysis used data for a current or baseline period (1961 to 1990) and provided a series of expected patterns for specific future time periods (e.g., 2046 – 2060).

The general precipitation pattern is presented on Figure A-15. The general annual average precipitation pattern for the Wyoming Basin ecoregion shows increasing precipitation from the northwest to the southeast, with the Grand Teton and Yellowstone areas receiving the most rainfall and the mid-basin areas (including the Bighorn Basin and parts of Southeast Wyoming) receiving the least.

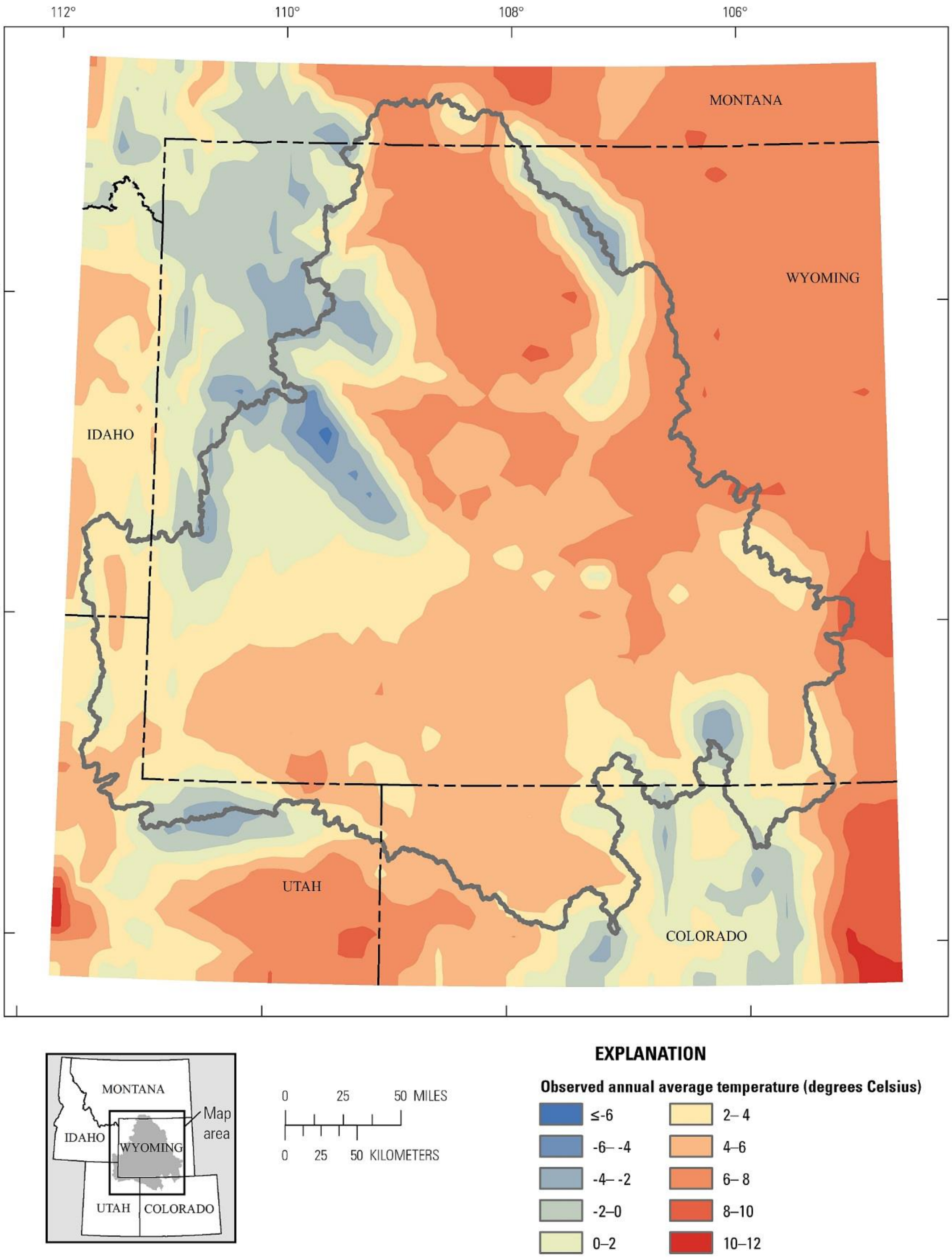
Figure A-15. Current (1961-1990) Total Annual Precipitation (millimeters)



Source: USGS, 2015

The mean annual temperature for existing climate pattern in the Wyoming Basin is presented on Figure A-16. The historical data indicate that the Bighorn Basin area of the Wyoming Basin is generally warmer than the rest of the ecoregion.

Figure 3-16. Current (1961-1990) Mean Annual Temperature (°C)



Source: USGS, 2015

The REA for the Wyoming Basin shows that all GCMs expect increased warming by 2030 and further warming by 2060. There was disagreement on the expected changes in precipitation amongst the models but the analysis did indicate an overall expectation for the future of wetter winters and drier summers.

All of North America is likely to experience an increase in average temperature during the next 100 years, and annual mean warming is likely to exceed global mean warming in most areas (IPCC, 2014).

Temperatures are projected to increase substantially by the end of this century (GCRP, 2009). Summer temperatures are expected to increase between approximately 7°F and 10+°F by 2080 to 2099. Overall, temperature in the region is projected to increase between 2.5°F to more than 13°F compared to the 1960 to 1979 baseline, depending on future GHG emissions (GCRP, 2009). This range of temperature increase reflects the current uncertainty in climate change modeling and represents the likely range of model projections, although lower or higher outcomes are possible.

Increasing temperatures are likely to contribute to increased evaporation, drought frequencies, and declining water quantity. The warming of lakes and rivers will adversely affect the thermal structure and water quality of hydrological systems, which will add additional stress to water resources in the region (IPCC, 2014). The area depends on temperature-sensitive springtime snowpack to meet demand for water from municipal, industrial, agricultural, recreational uses and BLM-authorized activities. The U.S. Geological Survey (USGS) notes that mountain ecosystems in the western U.S. are particularly sensitive to climate change, especially in the higher elevations, where much of the snowpack occurs, which have experienced three times the global average temperature increase over the past century. Higher temperatures are causing more winter precipitation to fall as rain rather than snow, which contributes to earlier snowmelt. Additional declines in snowmelt associated with climate change are projected, which would reduce the amount of water available during summer (GCRP, 2009). Rapid spring snowmelt due to sudden and unseasonal temperature increases can also lead to greater erosive events and unstable soil conditions.

Increases in average summer temperatures and earlier spring snowmelt are expected to increase the risk of wildfires by increasing summer moisture deficits (GCRP, 2009). Studies have shown that earlier snowmelts can lead to a longer dry season, which increases the incidence of catastrophic fire (Westerling et al., 2006). Together with historic changes in land use, climate change is anticipated to increase the occurrence of wildfire throughout the western U.S. The latest GCRP assessment (GCRP, 2014) predicts that temperatures and precipitation over the region will continue to increase, especially if GHG emissions remain high. In addition, the assessment predicts that the frequency of extreme weather events such as heat waves, droughts, and heavy rainfall will also increase and may affect water resources, forests and wilderness areas, agricultural and ranching activities, and human health.

There is evidence that recent warming is impacting terrestrial and aquatic biological systems, with higher temperatures leading to earlier timing of spring events such as leaf-unfolding, bird migration, and egg-laying (IPCC, 2014). The range of many plant and animal species has shifted poleward and to higher elevation, as the climate of these species' traditional habitat changes. As future changes in climate are projected to be even greater than those in the recent past, there will likely be even larger range shifts in the coming decades (Lawler et al., 2009). Warming temperatures are also linked to earlier "greening" of vegetation in the spring and longer thermal growing seasons (IPCC, 2014). In aquatic habitats, increases in algal abundance in high-altitude lakes have been linked to warmer temperatures, while range changes and earlier fish migrations in rivers have also been observed. Climate change is likely to combine with other human-induced stress to further increase the vulnerability of ecosystems to other pests, invasive species, and loss of native species. Climate change is likely to affect breeding patterns, water and food supply, and habitat availability to some degree. Sensitive species, such as the Greater Sage-Grouse, which are already stressed by declining habitat, increased development and other factors, could experience additional pressures as a result of climate change.

More frequent flooding events, erosion, wildfires and hotter temperatures all pose increased threats to cultural and paleontological sites and artifacts. Heat from wildfires, suppression activities and equipment, as well as greater ambient daytime heat can damage sensitive cultural resources. Similarly, flooding and erosion can wash away artifacts and damage cultural and paleontological sites. However, these same events may also uncover and lead to discoveries of new cultural and paleontological localities.
Climate change also poses challenges for many resource uses on BLM-administered land. Increased temperatures, drought and evaporation may reduce seasonal water supplies for livestock and could impact forage availability. However, in non-drought years, longer growing seasons resulting from thermal increases may increase forage availability throughout the year. Shifts in wildlife habitat due to climate change may influence hunting and fishing activities, and early snowmelt may impact winter and water-based recreational activities. Drought and resulting stress on vegetation is likely to increase the frequency and intensity of mountain bark beetle and other insect infestations, which further increases the risk of fire and reduces the potential for sale of forest products on BLM-administered lands.

A variety of activities currently generate GHGs. Fuels combustion, industrial processes and any number of other activities on public lands result in direct emissions of GHGs. Direct emissions in the include those related to current and ongoing oil and gas and other minerals development, fire events, motorized vehicle use (e.g., off-highway vehicles), livestock grazing, facilities development, and other fugitive emissions. Indirect GHG emissions include the demand for electricity generated outside the area. Contributions to climate change also result from land use changes (conversion of land to less reflective surfaces that absorb heat, such as concrete or pavement), and soil erosion (which can reduce snow's solar reflectivity and contribute to faster snowmelt).

Several federal initiatives have been launched to improve the ability to understand, predict, and adapt to the challenges of climate change. The Secretary of the Interior signed Secretarial Order 3289 on February 22, 2010, establishing a Department-wide, scientific-based approach to increase understanding of climate change and to coordinate an effective response to impacts on managed resources. The order reiterated the importance of analyzing potential climate change impacts when undertaking long-range planning issues, and also established several initiatives including the development of eight Regional Climate Science Centers (DOI, 2010). Regional Climate Science Centers would provide scientific information and tools that land and resource managers can apply to monitor and adapt to climate changes at regional and local scales. The North Central Climate Science Center was established in 2011.

Given the broad spatial influence of climate change which requires response at the landscape-level, the U.S. Department of the Interior (DOI) also established Landscape Conservation Cooperatives which are management-science partnerships that help to inform management actions addressing climate change across landscapes. These Cooperatives are formed and directed by land, water, wildlife and cultural resource managers and interested public and private organizations, designed to increase the scope of climate change response beyond federal lands.

Other federal initiatives are being implemented to mitigate climate change. The Carbon Storage Project was implemented to develop carbon sequestration methodologies for geological (i.e., underground) and biological (e.g., forests and rangelands) carbon storage. The project is a collaboration of federal agency and external stakeholders to enhance carbon storage in geologic formations and in plants and soils in an environmentally responsible manner. The Carbon Footprint Project is a project to develop a unified GHG emission reduction program for the DOI, including setting a baseline and reduction goal for the Department's GHG emissions and energy use. More information about DOI's efforts to respond to climate change is available at: www.doi.gov/whatwedo/climate/index.cfm.

In addition to DOI's efforts to address this issue, the EPA has undertaken a number of regulatory initiatives in recent years to reduce GHG emissions. For over 20 years, the EPA has developed approaches and strategies for reducing GHG emissions from natural gas operations through its Natural Gas Star Program (EPA, 2014). This program has provided recommendations for capturing or reducing fugitive emissions of VOCs, including hazardous air pollutants (HAP), as well as GHG's such as methane. In 2009, a finding was made under the Clean Air Act identifying the key constituent gases that threaten public health and welfare and contribute to climate change. An initiative was developed for mobile sources by setting engine and fuel standards to cut GHGs and fuel use for new motor vehicles, and the implementation of a renewable fuel standard aimed at decreasing oil imports and reducing GHGs. Another initiative addresses stationary sources to limit GHGs for power plants and other large industrial facilities. The EPA also initiated a national GHG emissions reporting program for large emitters. In 2012, EPA finalized regulations to reduce pollution from the oil and natural gas industry which is expected to result in substantial reductions in VOC emissions, air toxics, and CH_4, an important GHG (EPA, 2012). Most recently, EPA extended the rule to mandate control requirements for hydraulically fractured oil wells (EPA, 2015). In addition to requiring reduced emission completions (or "green completions") of oil wells, the rules also mandate that developers find and repair leaks, limit emissions from new and modified pneumatic pumps, and limit emissions from several types of equipment used at natural gas transmission compressor stations and at gas storage facilities, including compressors and pneumatic controllers. These actions, initiatives, and regulations will impact activities, especially those related to oil and natural gas development, in an overall effort to balance growth in resource development with continued reductions in key GHG emissions.

4.0 References

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